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SUMMARY OF
STATE-OF-THE-ART METHODOLOGY
AIR FORCE STRUCTURES, STRUCTURAL DYNAMICS
AND MATERIALS WORKSHOP

PRESENTED OCTOBER 3, 1980

AIR FORCE WRIGHT AERONAUTICAL LABORATORY
WRIGHT PATTERSON AIR FORCE BASE
DAYTON, OHIO

FOREWORD

This report is submitted as an addendum to CISM-AFOSR-80-1 dated September 1980, STATE-OF-THE-ARTS METHODOLOGY AIR FORCE STRUCTURES, STRUCTURAL DYNAMICS, AND MATERIALS WORKSHOP INTERIM REPORT. Through submission of this addendum, the previously submitted report, CISM-AFOSR-80-1, is now considered as a final report. This completes contract requirements associated with post conference summary of Contract Number F 49620-80-C-0042.

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ABSTRACT

This addendum summarizes the remarks resulting from the October 3, 1980 AIR FORCE STRUCTURES, STRUCTURAL DYNAMICS, AND MATERIALS WORKSHOP under the chairmanship of Dr. V. B. Vankayya. This workshop reflected summer research activity under a grant from AIR FORCE OFFICE OF SCIENTIFIC RESEARCH of original papers presented to the 21st AIAA/ASME/ASCE/AHS SDM Conference held in Seattle, Washington May 12-14, 1980. Attached to this report are two tapes which represent the full proceedings of the subject workshop. Dr. David Allen's work at Texas A & M with Professor Haisler has resulted in a grant from AFOSR to complete additional experimental correlation.

1.

Dr. V. B. Vankayya opened the session with some opening remarks and a welcome to the Air Force Wright Aeronautical Laboratory. Dr. Vankayya introduced Harry Harcrow who set the background of the workshop and introduced the student presentors. Fifty copies of the student papers were made available to the attendees.

This report shall discuss the highlights of each paper individually. Dr. Dorothy Reed was unable to attend the workshop; however, her paper was included with the proceedings.

DR. DAVID ALLEN - TEXAS A & M - "COMPUTATIONAL ASPECTS OF THE NON ISOTHERMAL CLASSICAL PLASTICITY"

Dr. Allen's original paper discussed thermal dynamic relevance of the theory with some comments on computational efficiency. The study activity included:

- * Acceptability to remaining field equation
- * Prediction of elastic/plastic and rate dependent material
- * Computational examples of the theory

Questions/Comments/Remarks:

1. You have utilized a universal axial theory?

Comment - A multi-axial theory along these lines are scheduled for presentation at the conference on "Computational Methods in Nonlinear Structural and Solid Mechanics" on 6-8 October 1980 with Professor Haisler. Phillips experimental work, Journal of Applied Mechanics December 1973, supports the approach taken.

2. Using a Von Mises criteria, what type of power value/law do you use?

Comment - We have used an exponential law, not a power law.

It corresponds to a single Maxwell element with a non-linear spring and dash pot. The solution procedure is a first order Runge-Kutta. The non-linearity of the problem really restricts the size of the load step to assure convergence. It is an incremental virtual work problem.

3. What is the computational efficiency?

Comment - Not very good at this time - however, some current investigations show promise. These include studies by Shampeni, Gear, and Henmarsh on a stiff equation solver package which uses a very sophisticated Runge-Kutta procedure. The problem now existing simply is the requirement for small load step intervals to assure convergence.

HAFSTEINN PALSSON - GEORGIA INSTITUTE OF TECHNOLOGY - "CLADDING + STRUCTURE
INTERACTION CASE STUDY FOR A HIGHRISE OFFICE TOWER"

Mr. Palsson's original paper discusses a numerical integration technique to define dynamic response of a tall vertical tower. The summer research study involved the application of this technique to a more complex structure to demonstrate associated dynamic interactions between structural elements. The study defined coupling effects of a cladding structure to a highrise office tower and their resulting dynamic interaction. The case study considered dynamic response of a 25 story office building to earthquake loadings and its

resulting dynamic response effect with the cladding structure. Five case studies were completed resulting in the following conclusions:

- * Increase in structural frequencies due to cladding higher for non-composite than composite models.
- * Significant increase in torsional frequencies which shows the effect of additional stiffness associated with cladding restraining twisting motion.

Questions/Comments/Remarks:

1. Any correlation of coupling between cladding and the forcing function used?

Comment - This was not investigated.

2. Was any test data available for correlation with analysis?

Comment - No, only ambient levels. Georgia Institute of Technology is hoping to place shakers on several test buildings to define test data.

3. Can this be done?

Comment - Yes, application of rectilinear shakers at Berkley has yielded adequate test data.

4. What model definition was used for the core?

Comment - Core model was developed using Strull. Each member considered as interacting; however, wall effect was not considered as they were not load carrying members.

5. What is ratio of cladding mass to building mass which might effect frequency shifts?

Comment - The mass of the panels are included within the combined structural model and is not designed to carry any stiffness. Masses are lumped at floor connection points; therefore, no cladding forces.

Remark - Consideration should be given to modal loading and forcing function effects. Identify principal modal responses. This should show direct loading effect, and response, to cladding.

PAUL WIENHOLD - UNIVERSITY OF MARYLAND - "IN-SITU REFORMATION ELECTRON MICROSCOPY AND ITS APPLICATION TO FRACTURE MECHANICS RESEARCH"

Remark - Paul Weinhold's paper was an extension of his original paper on an extensive review of Electron Microscopy. The workshop paper served as a tutorial in the areas of Electron Microscopy and its applications to Fracture Mechanics research. The paper was followed by a tour of the AFWAL Electron Microscopy laboratory conducted by Dr. V. B. Vankayya.

DR. DOROTHY REED - PRINCETON UNIVERSITY - "ARIMA REPRESENTATION OF LONGI-
TUDINAL, LATERAL, AND VERTICAL TURBULENCE SPECTRA"

Dr. Reed's original paper formulated variable wind loading for hyperbolic cooling tower and the determination of its resulting dynamic response. The summer research expanded this formulation to include "Autoregressive Integrated Moving Average (ARIMA)" models.

Remark - An outstanding study reflecting a statistical mechanic method which more closely aligns with aerodynamic loading of buildings. Dr. Reed was unable to attend due to overseas commitment.

CINDY LEE WHITE - UNIVERSITY OF NEW HAMPSHIRE - "NASTRAN ANALYSIS OF THE
HYDROGEN AND OXYGEN POWER REACTANT STORAGE ASSEMBLY TANKS"

Cindy White's original paper consisted of finite element modeling of a Shuttle Hydrogen PRSA tank and Signal Conditioner. The summer research study accomplished in association with the Beech Aircraft Corporation included model revision of the Hydrogen PRSA tank, modeling of an Oxygen PRSA tank, and generation of tank frequencies and random response analyses.

Questions/Comments/Remarks:

1. How was mass modelled?

Comment - Lumped masses was used at structural model attach points.

This included lumped mass representation of the tank fluid.

2. How about sloshing?

Comment - Fluid is filled under pressure; therefore, no sloshing.

Responses actually reflect support attachment response.

3. In your correlations, are the displacements to scale?

Comment - No, they are not to scale. They are expanded to give a better understanding of tank dynamic mode shapes.

Remark - Thanks were directed to Beech Aircraft Corporation for their support of this activity. Additionally, Beech Aircraft representatives were present and demonstrated a full scale tank.

DONNA MARLOWE - UNIVERSITY OF ALABAMA - "ROCKET DISPLACEMENT ERRORS DUE TO THRUST DISALIGNMENT AND MASS UNBALANCE"

Donna Marlowe's original paper presented a method to define/assess rocket path angle error due to pre-launch conditions. The summer research utilized this technique to demonstrate rocket displacement errors and to define stiffness optimization due to thrust misalignment and mass unbalance.

Questions/Comments/Remarks:

1. Are the transverse and longitudinal mass movements of inertia the same?

Comment - Yes.

2. Does your rocket model reflect lumped or distributive mass?

Comment - The rocket model is defined by a 11 point lumped mass model.

Remark - Closer examination of Donna Marlowe's model and results indicates an error in the model.

* As first question indicated, all mass movements of inertia are equal. This reflects a sphere and not a long slender model.

* The results clearly indicate a classical precision motion.

CONCLUDING REMARKS:

The results of the first Air Force Methodology Conference was gratifying. The papers indicated a real understanding of associated engineering principles and direct association with Air Force projects. Especially gratifying was the realization that Dr. Allen's paper has resulted in a Texas A & M grant for further experimental investigation.

The students were very grateful for the opportunity which was indicated by their individual dedication to the tasks assigned. Comments received from government, industry and universities universally praised the program. It is disappointing that the program for 1981 had to be deleted. However, a proposal will be submitted to AFOSR for 1982 funding.